Synthesis and Characterization of CO-and H_2S-Tolerant Electrocatalysts for PEM Fuel Cell

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ABSTRACT

In recent years, there has been growing interest in Proton Exchange Membrane Fuel Cell (PEMFC) technologies for down-to-earth applications because of its high power density, high efficiency and almost zero emission to the environment. The major focus on PEMFC technology is to develop fuel cell system for transportation applications, which require development of low cost cell components and reliable, high-purity H_2-fuel source. The PEMFC technology is attractive because of its low operating temperature and ease of start-up. Reformed methanol and liquid hydrocarbons are expected to be major fuel source in PEMFCs for terrestrial transportation application as envisioned in Vision 21 for the 21st century. The present state-of-art PEMFC technology is based on platinum (Pt) as a catalyst for both the fuel (anode) and air (cathode) electrodes. This catalyst is highly active but susceptible to poisoning by fuel impurities such as, H_2S and CO, which may be present in the H_2-fuel used or may be introduced during the fuel processing. These impurities poison the anode irreversibly and decrease the performance of the PEMFCs. This irreversible poisoning of the anode can happen even in CO concentrations as low as few ppm, and therefore, require expensive scrubbing of the H_2-fuel to reduce the contaminant concentration to acceptable level. In order to commercialize this environmentally sound source of energy/power system, development of suitable CO- and H_2S-tolerant catalyst is needed. The cost and reliability of electrocatalyst in PEMFCs are major impediments in commercial application. Innovations are needed to reduce system costs and to enhance operating life before fuel cell can become commercially competitive with conventional power generating systems.

We propose to develop CO- and H_2S-tolerant electrocatalysts for PEMFC anode by combining platinum with additional metallic components. . Ruthenium, a noble metal catalyst, is the preferred choice for providing CO tolerance. The sulfur tolerance may be imparted by a number of transition metals with molybdenum, cobalt, and tungsten as the leading candidates. Based on our current understanding and experience in the Pt-based bi-metallic and tri-metallic PEMFC electrocatalysts, we propose to further develop these electrocatalysts by fine tuning the metal

loadings and compositions to minimize the cost and optimize the catalyst activity and performance In the proposed program, therefore, anode electrocatalysts based on the Pt/Ru/transition metal compositions will be investigated. Effective techniques similar to the present state-of-the-art dispersed platinum/carbon electrode fabrication techniques will be used to synthesize the novel composition electrocatalysts. The feasibility of the novel electrocatalysts will be demonstrated in the proposed effort with gas phase CO and H_2S concentrations typical of those found in reformed fuel gas with coal/natural gas/methanol feedstocks. This proposal seeks US DOE support to further develop these electrocatalysts for PEM Fuel Cell electrodes.